

INK JET PRINTER

FIELD OF THE INVENTION

The present invention relates to an ink jet printer which makes print on a recording paper by running an ink carriage along a supporting axis in a reciprocating motion, and more particularly to an ink jet printer which can increase a printing rate.

BACKGROUND OF THE INVENTION

A conventional ink jet printer is disclosed in, for example, Japanese Laid-open Patent Application No. 24001/1994 (Japanese Official Gazette, Tokukaihei No. 6-24001, publishing date: February 1, 1994).

As shown in Figure 41(a), an ink jet printer disclosed in the above publication is arranged in such a manner that an ink carriage 100 is supported by a screw

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shaft 101 provided in a direction that intersects at right angles with a direction in which a recording paper 102 is transported, and the ink carriage 100 is allowed to run linearly along the screw shaft 101.

In addition, as shown in Figure 41(b), the ink carriage 100 has four ink tanks including a yellow ink tank 103a, a red ink tank 103b, a blue ink tank 103c, and a black ink tank 103d, each provided with their respective ink heads 104a, 104b, 104c, and 104d formed on the bottom surfaces facing the recording paper 102 downward.

Each of the ink heads 104a, 104b, 104c, and 104d is provided with a line of a plurality of ink nozzles 105 (eight in the drawing). Accordingly, a jet of ink is directed to the recording paper 102 simultaneously from each ink nozzle 105 in the line, so that print is made per line height, for example.

Thus, as shown in Figure 42, print is made by running the ink carriage 100 linearly directing a jet of ink downward to the recording paper 102 while the recording paper 102 is transported in the transportation direction.

However, the foregoing conventional ink jet printer has a problem that it can not increase a printing rate, because the printing rate is determined by a distance a

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recording paper has to travel in the printer, that is, the length of each line of the ink nozzles 105 and a running rate of the ink carriage 100.

The conventional ink jet printer has another problem that it can neither print out an overstrike character nor perform a double-side printing, and that it can not perform high-speed printing such that meets a user's demand when making print of high resolution or mixed information including, for example, a watermark and print data.

SUMMARY OF THE INVENTION

The present invention is devised to solve the above problems, and therefore, has an object to provide an ink jet printer which can improve printing efficiency by increasing a printing rate and printing resolution, and realizing printing of an overstrike character, simultaneous printing of mixed information, double-side printing, etc.

In order to fulfill the above and other objects, an ink jet printer of the present invention is an ink jet printer which makes print on a recording paper by running an ink carriage along a supporting axis in a reciprocating motion, characterized in that:

the ink carriage includes ink heads each provided

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In addition, by allocating print data to the ink nozzles facing their respective directions, an overstrike character can be printed out, the print resolution can be improved, and mixed information can be recorded by

transporting the recording paper only once. Further, by providing a switchback path mechanism, the double-side printing can be realized.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by increasing a printing rate and printing resolution, and realizing printing of an overstrike character, simultaneous printing of mixed information, double-side printing, etc.

For a fuller understanding of the nature and advantages of the invention, reference should be made to the ensuing detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows one embodiment of an ink jet printer of the present invention, and is a perspective view showing a state where a jet of ink is directed to a recording paper simultaneously from each of two groups of nozzles provided on an ink carriage and facing their respective directions;

Figure 2 is a perspective view depicting an arrangement of ink tanks on the ink carriage;

Figure 3 is a side elevation showing a state where a jet of ink is directed to a recording paper

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Figures 4(a) and 4(b) are views depicting an arrangement of each ink head on the ink carriage, Figure 4(a) being a view of the front ink head on the ink carriage seen from the back, Figure 4(b) being a view of the back ink head on the ink carriage seen from the back;

Figures 6(a) and 6(b) are views explaining an arrangement such that allows the pair of paper length adjusting rollers to move vertically, Figure 6(a) showing a state when the shortest distance is given between the nozzles, Figure 6(b) being a state when the longest distance is given between the nozzles;

Figures 7(a) through 7(c) are explanatory views showing a position of a portion on the recording paper printed by the front ink nozzles in relation to a position of a portion on the recording paper printed by the back ink nozzles, Figure 7(a) showing a state where the first line of the first half of the recording paper is printed out by the front ink nozzles and the first line of the latter half of the recording paper is printed out by the back ink nozzles, Figure 7(b) showing a state

where the second line of the first half of the recording paper is printed out by the front ink nozzles and the second line of the latter half of the recording paper is printed out by the back ink nozzles, Figure 7(c) showing a state where the printing of the first half of the recording paper by the front ink nozzle and the printing of the latter half of the recording paper by the back ink nozzles are completed;

Figure 8 is a flowchart detailing a control operation when the printing is effected simultaneously on the first half and latter half of one recording paper by the front ink nozzles and back ink nozzles, respectively;

Figure 9 is a perspective view showing a state where print is made on a first recording paper by the front ink nozzles and print is made on a second recording paper by the back ink nozzles simultaneously in the above ink jet printer;

Figure 10 is a flowchart detailing a control operation when print is made on the first recording paper by the front ink nozzles and print is made on the second recording paper by the back ink nozzles simultaneously;

Figures 11(a) and 11(b) are views depicting an arrangement of an ink jet printer in accordance with another embodiment of the present invention, Figure 11(a) showing a state when the shortest distance is given

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between the two groups of nozzles in case that a recording paper is guided by a transportation guide belt through the shortened/extended transportation path, Figure 11(b) showing a state when the longest distance is given between the two groups of nozzles in the same case;

Figures 12(a) and 12(b) are views showing a modified arrangement of the ink jet printer, Figure 12(a) showing a state when the shortest distance is given between the two groups of nozzles in case that the transportation path between the two groups of nozzles is formed by extendable guides and pairs of fixed paper length adjusting rollers in three stages are used, Figure 12(b) showing a state when the longest distance is given to the distance between the two groups of nozzles in case that the transportation path between the two groups of nozzles is formed by extendable guides and pairs of fixed paper length adjusting rollers in three stages are used;

Figure 13 is a flowchart detaining a control operation of the ink jet printer when the transportation path between the two groups of nozzles is formed by extendable guides and pairs of fixed paper length adjusting rollers in three stages are used;

Figures 14(a) and 14(b) are explanatory views showing an ink jet printer in accordance with still another embodiment of the present invention, Figure 14(a)

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showing the front ink head seen from the back when the front ink nozzles are assigned with odd-numbered columns, Figure 14(b) showing the back ink head seen from the back when the back ink nozzles are assigned with even-numbered columns;

Figures 15(a) through 15(c) are explanatory views of a printing state of the ink jet printer, Figure 15(a) showing print data of odd-numbered columns printed by the front ink nozzles, Figure 15(b) showing print data of even-numbered columns printed by the back ink nozzles, Figure 15(c) showing a state when print of even-numbered columns and print of odd-numbered columns are superimposed one on the other;

Figure 16 is a flowchart detailing a control operation when print data of even-numbered columns printed out by the back ink nozzles and print data of odd-numbered columns printed out by the front ink nozzles are superimposed one on the other;

Figures 17(a) and 17(b) are explanatory views showing a modified example of the ink jet printer, Figure 17(a) showing the front ink head seen from the back when the diameters of the ink drop of the front ink nozzles are made in order of "small", "large", "small", "large", ... in even-numbered columns, Figure 17(b) showing the back ink head seen from the back when the diameters of

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the ink drop of the back ink nozzles are made in order of "large", "small", "large", "small", ... in odd-numbered columns;

Figures 18(a) through 18(c) are explanatory views showing a printing state by the ink jet printer having more than one diameter of the ink drop, Figure 18(a) showing print data of odd-numbered columns printed out by the back ink nozzles, Figure 18(b) showing print data of even-numbered columns printed out by the front ink nozzles, Figure 18(c) showing a state when print of odd-numbered columns and print of even-numbered columns are superimposed one on the other;

Figures 19(a) and 19(b) are explanatory views showing another modified example of the ink jet printer, Figure 19(a) showing the front ink head seen from the back when the front ink nozzles are assigned with even-numbered rows, Figure 19(b) showing the back ink head seen from the back when the back ink nozzles are assigned with odd-numbered rows;

Figures 20(a) through 20(c) are explanatory views showing a printing state by the ink jet printer, Figure 20(a) showing print data of odd-numbered rows printed out by the back ink nozzles, Figure 20(b) showing print data of even-numbered rows printed out by the front ink nozzles, Figure 20(c) showing a state when print of the

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Figures 23(a) through 23(c) are explanatory views showing still another modified example of the ink jet printer, Figure 23(a) showing the front ink head seen from the back when the front ink nozzles are assigned with even-numbered rows and columns and the smaller diameter is given to the ink drop thereof, Figure 23(b)

and 23(c) showing the back ink head seen from the back when the back ink nozzles are assigned with odd-numbered rows and columns and the larger diameter is given to the ink drop thereof;

Figures 24(a) through 24(c) are explanatory views showing a printing state by the ink jet printer, Figure 24(a) showing print data of odd-numbered rows and columns printed out by the back ink nozzles with the ink drop of the larger diameter, Figure 24(b) showing print data of even-numbered rows and columns printed out by the front ink nozzles with the ink drop of the smaller diameter, Figure 24(c) showing a state when print of the odd-numbered rows and columns and print of the even-numbered rows and columns are superimposed one on the other;

Figures 25(a) through 25(c) are explanatory views showing an ink jet printer in accordance with still another embodiment of the present invention, by which a watermark and print data are superimposed and printed out on the same recording paper, Figure 25(a) showing a watermark, Figure 25(b) showing print data, Figure 25(c) showing resulting print when the watermark and print data are superimposed;

Figure 26 is a flowchart detailing a control operation when the watermark and print data are superimposed and printed out on the same recording paper;

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Figure 27 is a perspective view showing an arrangement of a switchback path mechanism provided in an ink jet printer in accordance with still another embodiment of the present invention;

Figure 28 is an explanatory view showing a transportation path, through which a recording paper is transported after print is made thereon by the back ink nozzles so as to be stored in a switchback case in the ink jet printer provided with the switchback path mechanism;

Figure 29 is a perspective view showing a state of the recording paper stored in the switchback case in the ink jet printer provided with the switchback path mechanism;

Figure 30 is an explanatory view showing a transportation path from the switchback case to the front ink nozzle position in the ink jet printer provided with the switchback path mechanism;

Figure 31 is a perspective view showing a state when the double-side printing is effected simultaneously on a plurality of recording papers by the ink jet printer provided with the switchback path mechanism;

Figure 32 is a flowchart detailing a control operation when the double-side printing is effected simultaneously on a plurality of recording papers by the

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ink jet printer provided with the switchback path mechanism;

Figure 33 is a view showing an arrangement of another switchback path mechanism provided to the ink jet printer;

Figure 34 is a view showing an arrangement of still another switchback path mechanism provided to the ink jet printer;

Figure 35 is a view showing an arrangement of still another switchback path mechanism provided to the ink jet printer;

Figure 36 is a view showing an arrangement of still another switchback path mechanism provided to the ink jet printer;

Figure 37 is a view showing an arrangement of still another switchback path mechanism provided to the ink jet printer;

Figure 38 shows an ink jet printer in accordance with still another embodiment of the present invention, and is a perspective view showing a drier device provided immediately after each group of ink nozzles;

Figure 39 is a perspective view showing a state when the drier device is installed in the ink jet printer provided with the switchback path mechanism;

Figure 40 is a perspective view showing a state when

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a back surface drying device is provided immediately after the switchback path mechanism;

Figures 41(a) and 41(b) show a conventional ink jet printer, Figure 41(a) being a perspective view showing a running state of an ink carriage, Figure 41(b) being a bottom view showing an arrangement of an ink head provided on the ink carriage; and

Figure 42 is a side elevation of the ink jet printer when the printing is effected by directing a jet of ink.

DESCRIPTION OF THE EMBODIMENTS

(Embodiment 1)

Referring to Figures 1 through 10, the following description will describe one embodiment of the present invention. In the present embodiment, a color printer is used as an example of an ink jet printer, but it should be appreciated that the present invention is not limited to the color printer, and can be a monochrome printer as well.

As shown in Figure 2, an ink jet printer of the present embodiment is provided with a supporting axis 1 set in a direction that intersects at right angles with a direction in which a recording paper 2 is transported and in a direction substantially parallel to the surface of the recording paper 2 being transported, and an ink

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carriage 5 is attached to the supporting axis 1 in such a manner that it is allowed to run to-and-fro along the supporting axis 1. The ink carriage 5 runs linearly, and a runway portion and an overrun portion are secured at the both ends, respectively.

The ink carriage 5 includes an ink tank 3 composed of a yellow ink tank 3a, a red ink tank 3b, a blue ink tank 3c, and a black ink tank 3d, which are aligned sequentially and filled with yellow ink, red ink, blue ink, and black ink, respectively.

As shown in Figure 3, the ink carriage 5 of the present embodiment is provided with a front ink head 6 and a back ink head 7 facing their respective directions, so that the printing can be effected on the recording paper 2 simultaneously at two portions along the transportation direction in which the recording paper 2 is transported through a single transportation path sequentially one by one.

In other words, as shown in the drawing, the front ink head 6 is provided at the bottom of the front surface of the ink tank 3 so as to face the front side, whereas the back ink head 7 is provided at the bottom of the back surface so as to face the back side. Thus, it is arranged such that the directions of jets of ink from the front ink head 6 and back ink head 7 are horizontal and

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oppose each other.

On the other hand, the transportation path of the recording paper 2 is substantially a U-shape as curved along (going around) the outer surface of the ink carriage 5. Thus, the transportation path is also curved along the outer surface of the supporting axis 1. According to this arrangement, the outer surface of the ink carriage 5 opposes the curved transportation path at the front and back, and it is preferable that substantially the same space is given between the transportation path and the outer surface opposing at the front and back. Also, at least one of the supporting axis 1 and ink carriage 5 is provided to block a virtual extension line of the transportation path heading the printing portions by the ink carriage 5. By providing the transportation path in the above manner, the printing at two portions from the front ink head 6 and back ink head 7 can be effected in a reliable manner.

As shown in Figure 4(a), the front ink head 6 is provided with lines of front ink nozzles 4a in their respective colors, each line being slanted downward to the right and composed of, for example, eight nozzle holes. Consequently, a jet of ink is directed to the recording paper 2 from each line of the ink nozzles 4a on the front surface of the ink carriage 5 simultaneously in

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a horizontal direction per line height.

On the other hand, as shown in Figure 4(b), the back ink head 7 is provided with lines of back ink nozzles 4b in their respective colors, each line being slanted downward to the left and composed of eight nozzle holes. Consequently, a jet of ink is directed to the recording paper 2 from each line of the ink nozzles 4b on the back surface of the ink carriage 5 simultaneously in a horizontal direction per line height in the same manner as the front ink head 6.

Therefore, as shown in Figure 1, while one recording paper 2 is transported through the transportation path so as to pass by the ink carriage 5 from the back to the front by going under, a jet of ink is directed to the recording paper 2 from the front ink nozzles 4a to print out the first half of data, for example, data of first 15 lines in the transportation direction, while at the same time, a jet of ink is directed to the recording paper 2 from the back nozzles 4b to print out the latter half of the data, that is, data of 15 lines following the first 15 lines. It should be appreciated that the number of lines printed out by each group of the front ink nozzles 4a and back ink nozzles 4b is determined by software run for the printing job. Therefore, the arrangement is not limited to the foregoing, and a jet of ink can be

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directed to the recording paper 2 from the front ink nozzles 4a to print out data of the first 5 lines in the transportation direction, while at the same time, a jet of ink can be directed to the recording paper 2 from the back nozzles 4b to print out data of the latter 5 lines in the transportation direction.

In the present embodiment, the ink carriage 5 includes two ink heads provided with the front ink head 6 and back ink head 7 facing their respective directions so that printing is effected on the recording paper 2 simultaneously at two portions along the transportation direction in which the recording paper 2 is transported through a single transportation path sequentially one by one. However, the arrangement is not limited to the foregoing, and the printing can be effected simultaneously at more than two portions on the recording paper 2 along its transportation direction. For example, by providing an unillustrated ink head facing downward in addition to the front ink head 6 and back ink head 7, printing can be effected simultaneously at three portions along the transportation direction of the recording paper 2 adequately by the three ink heads facing their respective directions each assigned by software with any number of lines that should be printed.

As has been discussed, the supporting axis 1 is used

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to allow the ink carriage 5 to run along the main running direction in a stable manner while the recording paper 2 is transported. Because the printing is effected by the front ink nozzles 4a and back ink nozzles 4b respectively provided on the two opposing side surfaces of the ink carriage 5, the supporting axis 1 is provided under the ink carriage 5 so as not cause any trouble during the printing.

When the ink carriage 5 is allowed to move in the main running direction, it moves to-and-fro along the supporting axis 1 in association with the recording paper 2 transported for the transmission data. As shown in Figure 5, the recording paper 2 is transported by passing a space between a pair of paper length adjusting rollers 8 provided below the supporting axis 1 as nozzle distance adjusting means.

As shown in Figures 6(a) and 6(b), the pair of paper length adjusting rollers 8 transport the recording paper 2 when driven by a roller driving motor 9 having a gear 9a that engages with one of the paper length adjusting rollers 8 at the driving end.

The pair of paper length adjusting rollers 8 of the present embodiment are arranged so as to change their position vertically by allowing a paper length adjusting bearing frame 12 to move vertically depending on the

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length (hereinafter, referred to as full length) in the sub-running direction (transportation direction) of the recording paper 2 being transported.

Thus, when the full length of the recording paper 2 is short, the paper length adjusting bearing frame 12 approximates to the ink carriage 5 as shown in Figure 6(a). On the other hand, when the full length of the recording paper 2 is long, the paper length adjusting bearing frame 12 moves away from the ink carriage 5 as shown in Figure 6(b).

Therefore, by vertically moving the pair of paper length adjusting rollers 8 for the recording paper 2 of any length, the ink jet position of the front ink nozzles 4a can be set exactly where the first line in the first half of the recording paper 2 should be printed out, while at the same time the ink jet position of the back

ink nozzles 4b can be set exactly where the first line in the latter half of the recording paper 2 should be printed out.

As shown in Figure 7(a), by running the ink carriage 5 forward in the main running direction under these conditions, a jet of ink is directed from the front ink nozzles 4a to the recording paper 2, whereby the first line in the first half of the recording paper 2 along its transportation direction is printed out, while at the same time, a jet of ink is directed from the back ink nozzles 4b to the recording paper 2, whereby the first line in the latter half of the recording paper 2 along its transportation direction is printed out.

Next, as shown in Figure 7(b), by running the ink carriage 5 backward in the main running direction, the second line in the first half of the recording paper 2 along its transportation direction is printed out by the front ink nozzles 4a, while at the same time the second line in the latter half of the recording paper 2 along its transportation direction is printed out by the back ink nozzles 4b.

By repeating the above operations, the first half data for the recording paper 2 is printed out by the front ink nozzles 4a and while at the same time the latter half data for the recording paper 2 is printed out

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by the back ink nozzles 4b.

Then, as shown in Figure 7(c), the last line printed out by the front ink nozzles 4a is connected to the first line printed out by the back ink nozzles 4b, thereby making it possible to print out the full data by each of the two groups of ink nozzles 4a and 4b.

Incidentally, in the present embodiment, as shown in Figures 6(a) and 6(b), extendable guides 10 are provided in the transportation path of the recording paper 2 respectively at the front and back of the pair of paper length adjusting rollers 8 as extendable guiding means. The extendable guides 10 guide the recording paper 2 to secure the transportation path of an adequate length between the two groups of ink nozzles 4a and 4b, so that the recording paper 2 is transported to the accurate position at the front of the ink carriage 5 through a space between the pair of paper length adjusting rollers 8.

In other words, as has been discussed, because the pair of paper length adjusting rollers 8 move vertically depending on the full length of the recording paper 2, the recording paper 2 may not be transported smoothly if the length of the guides is fixed.

Therefore, the extendable guides 10 are made adjustable, that is, allowed to extend or contract in

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Next, the following description will describe an operation involved in the printing step of the foregoing ink jet printer with reference to the flowchart of Figure 8.

Then, the recording paper 2 is transported to the position at which the first line in the first half of the recording paper 2 is printed out by the front ink nozzles 4a (S3). Accordingly, the recording paper is also set to the position at which the first line in the latter half of the recording paper 2 is printed out by the back ink

nozzles 4b.

Then, the first half data of one page is stored in a print memory for the front ink nozzles 4a, while the latter half data of one page is stored in a print memory for the back ink nozzles 4b (S4).

Subsequently, the data is sent to the front ink nozzles 4a and back ink nozzles 4b from their respective print memories, and simultaneous printing by the two groups of ink nozzles 4a and 4b is effected by running the ink carriage 5 once, after which the recording paper 2 is transported by a running width, that is, one line (S5).

Then, whether or not the data of one page has been printed out by the two groups of ink nozzles is judged (S6), and if not, the flow returns to S5 to repeat the printing and paper-transportation by a running width. On the other hand, if the data of one page has been printed out in S6, the recording paper 2 is released (S7).

Whether there is data of a next page or not is judged (S8), and if there is no data, the flow ends; otherwise, the flow returns to repeat S1 and S1-S8 are repeated.

By effecting the printing of the first half and latter half simultaneously in the above manner, a high-speed printing can be realized.

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As has been discussed, in the ink jet printer of the present embodiment, the ink carriage 5 includes the front ink head 6 and back ink head 7 respectively provided with the front ink nozzles 4a and back ink nozzles 4b facing their respective directions, so that the printing can be effected on the recording paper 2 simultaneously at more than one portion along the transportation direction in which the recording paper 2 is transported through the single transportation path sequentially one by one.

Thus, by running one ink carriage 5, the printing can be effected simultaneously at more than one portion on the same recording paper 2 along the transportation direction thereof. Accordingly, in case of monochrome printing, the printing time can be shortened compared with a case using an ink head provided with ink nozzles facing only one direction.

Also, by allocating the print data to the front ink nozzles 4a and back ink nozzles 4b facing their respective directions, an overstrike character can be printed out, the printing resolution can be improved, or mixed information can be recorded by transporting the recording paper 2 only once. The recording of mixed information referred to herein includes a case where a jet of ink of a different color is directed from each group of the back ink nozzles 4b and front ink nozzles

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4a.

Further, by providing a switchback path mechanism, the double-side printing can be realized.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by increasing a printing rate and printing resolution, and realizing printing of an overstrike character, simultaneous printing of mixed information, double-side printing, etc.

Also, in the ink jet printer of the present embodiment, the ink carriage 5 includes the front ink head 6 and back ink head 7 respectively provided with the front ink nozzles 4a and back ink nozzles 4b facing their respective directions, so that the printing can be effected on the recording paper 2 simultaneously at two portions along the transportation direction in which the recording paper 2 is transported through the single transportation path sequentially one by one.

Thus, by running one ink carriage 5, the printing can be effected simultaneously at two portions on the same recording paper 2 along the transportation direction thereof. Accordingly, in case of monochrome printing, the printing time can be shortened to half the printing time when using an ink head provided with ink nozzles facing only one direction.

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Also, by allocating the print data to the front ink nozzles 4a and back ink nozzles 4b facing their respective directions, an overstrike character can be printed out, the printing resolution can be improved, and mixed information can be recorded by transporting the recording paper 2 only once. The recording of the mixed information referred to herein includes a case where a jet of ink of a different color is directed from each group of the back ink nozzles 4b and front ink nozzles 4a.

Further, by providing the switchback path mechanism as will be discussed below, the double-side printing can be realized.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by increasing a printing rate and printing resolution, and realizing printing of an overstrike character, simultaneous printing of mixed information, double-side printing, etc.

Incidentally, in order to effect the printing at two portions exactly at the preset recording position in the recording paper 2 by the front ink head 6 provided with the front ink nozzles 4a facing one direction and the back ink head 7 provided with the back ink nozzles 4b facing another direction with respect to the

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transportation direction of the recording paper 2, a distance between the groups of ink nozzles facing their respective directions in the transportation path has to be adjusted; otherwise the printing can not be effected exactly at two intended portions on the recording paper 2.

However, according to the ink jet printer of the present embodiment, the pair of paper length adjusting rollers 8 are provided to adjust a distance between the front ink nozzles 4a and back ink nozzles 4b facing their respective directions in the transportation path, so that the printing can be effected at the two set recording positions on the recording paper 2 by the front ink head 6 provided with the front ink nozzles 4a facing one direction and the back ink head 7 provided with the back ink nozzles 4b facing another direction with respect to the transportation direction of the recording paper 2.

By adjusting the distance between the front ink nozzles 4a and back ink nozzles 4b in the transportation path by the pair of paper length adjusting rollers 8, printing can be effected exactly at the intended two portions on the recording paper 2 along the transportation direction thereof.

In addition, because the pair of paper length adjusting rollers 8 adjust the distance between the front

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ink nozzles 4a and back ink nozzles 4b in the transportation path, printing can be effected exactly at the intended two portions on the recording paper 2 of any length along the transportation direction thereof.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by increasing a printing rate and printing resolution, and realizing printing of an overstrike character, simultaneous printing of mixed information, etc.

According to the present embodiment, half the length of the recording paper 2 set for the printing is given as a length of the transportation path between the front ink nozzles 4a and back ink nozzles 4b, so that the printing can be effected simultaneously on each of the first half and latter half of the recording paper 2 by the ink carriage 5 provided with the front ink nozzles 4a and back ink nozzles 4b facing their respective directions.

Consequently, printing can be effected simultaneously at the first half and latter half of one recording paper 2 by the back ink nozzles 4a and front ink nozzles 4b, thereby making it possible to shorten the printing time to half the printing time when using an ink head provided with ink nozzles facing only one direction.

According to the present embodiment, half the length of the recording paper 2 used for the printing is given

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Consequently, printing can be effected simultaneously at the first half and latter half of one recording paper 2 by the front ink nozzles 4a and back ink nozzles 4b, thereby making it possible to shorten the printing time to half.

According to the present embodiment, half the length of the recording paper 2 used for the printing is given as a length of the transportation path between the front ink nozzles 4a and back ink nozzles 4b, so that the printing can be effected simultaneously on each of the first half and latter half of the recording paper 2 by the ink carriage 5 provided with the front ink nozzles 4a and back ink nozzles 4b facing their respective directions while the recording paper 2 is transported such that where the first line of the latter half should be printed out is at the printing position of the back

between the front ink nozzles 4a and back ink nozzles 4b on the transportation path is adjusted by the pair of paper length adjusting rollers 8 at command from a paper selection switch provided on an unillustrated display panel of the ink jet printer.

increasing a printing rate and printing resolution, and realizing printing of an overstrike character, simultaneous printing of mixed information, double-side printing, etc.

Further, the recording paper 2 of any size is available.

According to the present embodiment, not only the pair of paper length adjusting rollers 8 are provided to extend/shorten the transportation path in response to the paper size, but also the extendable guides 10 are provided on the transportation path so as to operate in association with the pair of paper length adjusting rollers 8.

Therefore, the transportation path of an adequate length can be secured by extending/shortening the extendable guides 10 in response to the paper size. In addition, because the back ink nozzles 4b and front ink nozzles 4a facing their respective directions are provided, the printing can be effected simultaneously at two portions by the back ink nozzles 4b and front ink nozzles 4a by running the ink carriage 5 once. Therefore, the printing efficiency can be improved while the printing time is shortened. In addition, the transportation path can be readily adjusted, and the recording paper 2 of any size is available.

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In the present embodiment, the printing is effected by directing a jet of ink from the front ink nozzles 4a and back ink nozzles 4b to the first half and latter half of one recording paper 2 simultaneously and respectively. However, the arrangement is not limited to the foregoing, and the printing may be effected simultaneously on two recording papers 2 by using the above scheme.

In other words, as shown in Figure 9, when more than one recording paper 2 transported one by one exists in the single transportation path, the printing can be accelerated by directing jets of ink from the front ink nozzles 4a to the first recording paper 2a and a jet of ink from the back ink nozzles 4b to the second recording paper 2b.

More specifically, as shown in the drawing, the pair of paper length adjusting rollers 8 are moved to meet the full length of the recording papers 2a and 2b.

Then, the first recording paper 2a is transported in such a manner that the top end thereof reaches the opposing position to the front ink jet nozzles 4a, and the second recording paper 2b is transported in such a manner that the top end thereof reaches the opposing position to the back ink jet nozzles 4b, so that the printing can be started from the intended position in each recording paper.

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The following description will describe the control action when effecting the printing is effected simultaneously on two recording papers with reference to the flowchart of Figure 10.

In the first place, the pair of paper length adjusting rollers 8 are set at a position to secure a distance as long as or longer than the full length of the recording paper 2. In other words, the pair of paper length adjusting rollers 8 are set such that the latter end of the recording paper 2 is transported beyond the ink jet directing position of the back ink nozzles 4b (S11). Then, the ink jet printer receives data of one page, and stores the same in the print memory of the front ink nozzles 4a (S12).

Then, the first recording paper 2a is transported (S13). Here, whether there is data of a second page or not is checked (S14). If so, the ink jet printer receives the data for the second recording paper 2b, and stores the same in the print memory of the back ink nozzles 4b (S15), and the second recording paper 2b is transported to a position such that the printing is effected thereon by the back ink nozzles 4b (S16).

Then, the data is sent to the front ink nozzles 4a and back ink nozzles 4b from their respective print memories, and a jet of ink is directed to each of the first and second recording papers 2a and 2b simultaneously by the front ink nozzles 4a and back ink nozzles 4b, respectively, whereby data of one page is printed out on each of the recording papers 2a and 2b (S17).

When the printing ends, the recording papers 2a and 2b are released sequentially in this order (S18).

When there is data of the following page after the two recording papers 2a and 2b are released (S19), the flow returns to S12, and S12-S19 are repeated.

Also, when there is data of only one page in S14, data of one page is sent to the front ink nozzles 4a from the print memory, and printed out on the recording paper 2a (S20). When the printing ends, the printed recording

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paper 2a is released (S21).

Simultaneous printing on two recording papers can be realized by the foregoing steps.

As has been discussed, in the present embodiment, a distance as long as or longer than the length of the recording paper 2 used for the printing is secured as a distance of the transportation path between the two groups of the back ink nozzles 4b and front ink nozzles 4a provided on the ink carriage 5, and the printing is effected simultaneously on the two recording papers 2a and 2b by the two groups of the front ink nozzles 4a and back ink nozzles 4b, respectively.

Consequently, the printing can be effected simultaneously on the two separate recording papers 2a and 2b by the two groups of the front ink nozzles 4a and back nozzles 4b, respectively. Thus, in case that the printing is effected on more than one recording paper 2, the printing time can be shortened to half the printing time when using the ink head provided with ink nozzles facing only one direction.

According to the present embodiment, when the printing is effected simultaneously on two recording papers 2a and 2b by the two groups of the front ink nozzles 4a and back ink nozzles 4b, respectively, by securing a distance as long as or longer than the length

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Therefore, in case that the printing is effected on more than one recording paper, the printing is effected on the recording papers 2a and 2b by the front ink nozzles 4a and back ink nozzles 4b from their respective top positions, thereby making it possible to increase the printing rate and efficiency.

According to the present embodiment, when the printing is effected simultaneously on two recording papers 2a and 2b by the two groups of the front ink nozzles 4a and back ink nozzles 4b, respectively, by securing a distance as long as or longer than the length of the recording paper 2 used for the printing as a distance of the transportation path between the two groups of the back ink nozzles 4b and front ink nozzles 4a provided on the ink carriage 5 based on the length of

the recording paper 2 set for the printing, the printing is effected simultaneously on two recording papers 2a and 2b by the two groups of the front ink nozzles 4a and back ink nozzles 4b, respectively, under the condition that the top end of the recording paper 2a is at the printing position of the front ink nozzles 4a and the latter end thereof is beyond the printing position of the back ink nozzles 4b on the transportation path.

Consequently, the latter end of the recording paper 2a fed first does not overlap the top end of the recording paper 2b set at the printing position of the back ink nozzles 4b so that the printing is effected by the same, thereby making it possible to effect the printing on two recording papers simultaneously.

According to the present embodiment, when the printing is effected simultaneously on two recording papers 2a and 2b by the two groups of the front ink nozzles 4a and back ink nozzles 4b, respectively, by securing a distance as long as or longer than the length of the recording paper 2 used for the printing as a distance of the transportation path between the two groups of the back ink nozzles 4b and front ink nozzles 4a provided on the ink carriage 5 based on the length of the recording paper 2 set for the printing, the printing is effected simultaneously on two recording papers 2a and

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2b by the two groups of the front ink nozzles 4a and back ink nozzles 4b, respectively, under the condition that the top end of the recording paper 2a is at the printing position of the front ink nozzles 4a and the latter end thereof is beyond the printing position of the back ink nozzles 4b on the transportation path while the top end of the following recording paper 2b is set at the printing position of the back ink nozzles 4b.

Consequently, the recording papers 2a and 2b do not overlap one on the other, whereby the printing can be effected on the two recording papers 2a and 2b from the first line in each.

According to the present embodiment, when the printing is effected simultaneously on two recording papers 2a and 2b by the two groups of the front ink nozzles 4a and back ink nozzles 4b, respectively, by securing a distance as long as or longer than the length of the recording paper 2 used for the printing as a distance of the transportation path between the two groups of the back ink nozzles 4b and front ink nozzles 4a provided on the ink carriage 5 based on the length of the recording paper 2 set for the printing, the printing is effected simultaneously on two recording papers 2a and 2b by the two groups of the front ink nozzles 4a and back ink nozzles 4b, respectively, by providing the same with

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labeled with like reference numerals with respect to Embodiment 1, and the description of these components is not repeated for ease of explanation.

In Embodiment 1 above, as shown in Figures 6(a) and 6(b), the extendable guides 10 are provided as extendable guiding means at the front and back of the pair of paper length adjusting rollers 8 on the transportation path of the recording paper 2, whereby the recording paper 2 is guided so as to reach the front of the ink carriage 5 through a space between the pair of paper length adjusting rollers 8 adequately.

However, the extendable guiding means for realizing smooth transportation of the recording paper 2 is not limited to the extendable guides 10.

In other words, in the present embodiment, as shown in Figures 11(a) and 11(b), for example, a transportation guide belt 14 is provided as the extendable guiding means instead of the extendable guides 10.

The transportation guide belt 14 is put across four rollers: (1) a back post-printing transportation roller 17 on the rear side, which is one of a pair of back post-printing transportation rollers 17 provided at a position where the printing on the recording paper 2b by the back ink nozzles 4b provided on the ink carriage 5 is just finished: (2) one of the paper length adjusting rollers

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8 at the top end; (3) a front pre-printing transportation roller 18 on the front side, which is one of the pair of front post-printing transportation rollers 18 provided at a position where the printing on the recording paper 2b by the front ink nozzles 4a is just started; and (4) a tension roller 15 which is provided at the bottom and rotates in association with the rotation of the transportation guide belt 14.

The tension roller 15 is provided to a belt bearing frame 16 which fits into a motor gear 13a of the frame driving motor 13. Thus, by driving the frame driving motor 13, the belt bearing frame 16 moves vertically, in accordance with which the tension roller 15 moves vertically.

In addition, as has been discussed in Embodiment 1, the motor gear 13a of the frame driving motor 13 also fits into the paper length adjusting bearing frame 12. Hence, when the paper length adjusting bearing frame 12 moves upward, the belt bearing frame 16 moves downward, and when the paper length adjusting bearing frame 12 moves downward, the belt bearing frame 16 moves upward.

Consequently, when the pair of paper length adjusting rollers 8 provided to the paper length adjusting bearing frame 12 move upward/downward, the tension roller 15 moves downward/upward in a reverse

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Accordingly, after the recording paper 2b passes through a space between the pair of back post-printing transportation rollers 17, it is guided by the transportation guide belt 14 to go through a space between the pair of paper length adjusting rollers 8 and a space between the pair of front pre-printing transportation rollers 18 to reach the ink jet directing position of the front ink nozzles 4a in an adequate manner depending on the distance between the ink nozzles 4a and 4b.

In the above-discussed method, the pair of paper length adjusting rollers 8 serving as nozzle distance adjusting means are provided to the paper length adjusting bearing frame 12 and thereby being allowed to move vertically. However, in the alternative method, as shown in Figures 12(a) and 12(b), a pair of short paper length adjusting rollers 20, a pair of medium paper

length adjusting rollers 21, and a pair of long paper length adjusting rollers 22 are provided sequentially in three stages as the nozzle distance adjusting means fixed somewhere below the ink carriage 5 at positions corresponding to their respective paper length.

Then, each of extendable guides 30 serving as the extendable guiding means of the present embodiment is composed of, like the extendable guides 10 discussed in Embodiment 1, a first back surface guide 31, a second back surface guide 32, and a third back surface guide 33 for the one at the rear side, and a first front surface guide 36, a second front surface guide 37, and a third front surface guide 38 for the one at the front side. However, different from the extendable guides 10, the springs 11 used in extending and contracting the same are omitted.

The extendable guides 30 are instead arranged in the following manner. That is, the first back surface guide 31, second back surface guide 32, and third back surface guide 33 are allowed to rotate around their respective linking axes 31a, 32a, and 33a. Likewise, the first front surface guide 36, second front surface guide 37, third surface guide 38 are allowed to rotate around their respective linking axes 36a, 37a, and 38a.

Also, the second back surface guide 32, third back

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solenoid 35, second front surface guide solenoid 39, and third front surface guide solenoid 29, respectively, which form mechanism such that smoothly opens the second back surface guide solenoid 34, third back surface guide solenoid 35, second front surface guide solenoid 39, and third front guide solenoid 29, respectively.

The following will explain a control operation of each guide by the above-arranged extendable guides 30 upon detection of the paper size with reference to the flowchart of Figure 13.

In the first place, whether the recording paper 2 is of an ISO size B4 or larger is judged (S31). When the recording paper 2 is a large-size paper, such as ISO size A3 and ISO size B4, as shown in Figure 12(b), the recording paper 2 is transported and the printing is effected thereon with the second back surface guide solenoid 34, third back surface guide solenoid 35, second front surface guide solenoid 39, and third front surface guide solenoid 29 all being released (S36).

When the recording paper 2 is judged as being smaller than the ISO size B4 in S31, then whether the recording paper 2 is larger than the ISO size A4 or not is judged (S32).

When the recording paper 2 is judged as being not larger than the ISO size A4 in S32, such as the ISO size

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embodiment uses the transporting guide belt 14 instead of the two extendable guides 10, and includes the tension roller 15 which maintains the tension of the transporting guide belt 14 at a constant level so as to keep the transportation performance. The position of the tension roller 15 varies in association with the movement of the pair of paper length adjusting rollers 8 which change its position in response to the paper size.

Consequently, the adequate transportation path for the recording paper 2 of any length used in printing can be secured. In addition, because the back ink nozzles 4b and front ink nozzles 4a facing their respective directions are provided, the printing can be effected simultaneously at two portions by the back ink nozzles 4b and front ink nozzles 4a by running the ink carriage 5 once, thereby realizing efficient printing while shortening the printing time. Further, the transportation path can be readily adjusted and the recording paper of any size can be used.

In addition, by using the transportation guide belt 14, the occurrence of a transportation jamming trouble caused when, for example, the recording paper 2 is hooked by the rib or the like can be reduced.

Further, by providing the tension roller 15, stable transportation performance can be offered all the time.

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Also, by moving the tension roller 15 in association with the pair of paper length adjusting rollers 8 by means of one motor, the arrangement of the pair of paper length adjusting rollers 8 and transportation guide belt 14 can be simplified, while at the same time, the recording paper 2 can be guided in a precise manner depending on its paper length. Consequently, the ink jet printer can be designed at a low cost.

In addition, according to the present embodiment, the pair of short paper length adjusting rollers 20, the pair of medium paper length adjusting rollers 21, the pair of long paper length adjusting rollers 22 are provided sequentially in the three stages as the nozzle distance adjusting means, and three guides including the first back surface guide 31, second back surface guide 32, third back surface guide 33 are provided at the rear side, and three guides including the first front surface guide 36, second front surface guide 37, and third front surface guide 38 are provided at the front side. Further, the foregoing guides are provided with linking axes 31a, 32a, 33a, 36a, 37a, and 38a each serving as a rotating axis. Also, by pulling the end portions of the second back surface guide 32, third back surface guide 33, second front surface guide 37, third front surface guide 38 by the second back surface guide solenoid 34,

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Thus, the adequate transportation path can be secured for the recording paper of any size. In addition, because the back ink nozzles 4b and front ink nozzles 4a facing their respective directions are provided, the printing can be effected simultaneously at two portions by the back ink nozzles 4b and front ink nozzles 4a by running the ink carriage 5 once, thereby realizing efficient printing while shortening the printing time.

Moreover, the nozzle distance adjusting means and extendable guiding means can be provided in a small space. Further, not only can the extendable guides 30 be

adjusted precisely depending on the paper size, but also the paper size can be changed mechanically in a short time.

(Embodiment 3)

Referring to Figures 14 through 24, the following description will describe still another embodiment of the present invention. Hereinafter, like components are labeled with like reference numerals with respect to Embodiments 1 and 2, and the description of these components is not repeated for ease of explanation.

An ink jet printer of the present embodiment is identical with its counterpart of Embodiment 1 having two groups of front ink nozzles 4a and back ink nozzles 4b on the single ink tank 3, except that holes of the front ink nozzles 4a are shifted by half the pitch in the running direction from the holes of the back ink nozzles 4b so as to realize high resolution printing. One pitch referred to herein means a distance (length) the recording paper 2 moves per running, and a space between the printing position for a running and the printing position for the next running.

In other words, as shown in Figure 14(a), the front ink nozzles 4a in the front ink head 6 are aligned in a line slanted downward to the right with respect to the

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Thus, the front ink nozzles 4a and back ink nozzles 4b are assigned for the printing of odd-numbered columns and the printing of even-numbered columns, respectively, and as shown in Figure 15(a), the odd-numbered columns are printed out first by the back ink nozzles 4b, and then, as shown Figure 15(b), the even-numbered columns are printed out by the front ink nozzles 4a on the

In the foregoing, the front ink nozzles 4a are assigned for the printing of odd-numbered columns and the back ink nozzles 4b are assigned for the printing of even-numbered columns. However, switching such an assignment does not cause any problem.

In the first place, the ink jet printer receives data of one page, and data of the odd-numbered columns is stored in the front ink nozzle print memory, while data of the even-numbered columns is stored in the back ink nozzle print memory (S41). Then, the recording paper 2 is transported to the printing position of the back ink nozzles 4b (S42), and the data is sent to the back ink nozzles 4b from the back surface ink nozzle print memory. Subsequently, the printing is effected by running the ink carriage 5 once, and the recording paper 2 is transported

by one running width, that is, by one line (S43).

Then, whether the recording paper 2 has reached the printing position of the front ink nozzles 4a or not is judged (S44). If not, the flow returns to S43, and S43 and S44 are repeated until the recording paper 2 reaches the printing position of the front ink nozzles 4a.

When it is judged that the recording paper 2 has reached the printing position of the front ink nozzles 4a in S44, data is sent to the back ink nozzles 4b from the back ink nozzles print memory, while at the same time data is sent to the front ink nozzles 4a from the front ink nozzle print memory, so that data is printed out by the two groups of ink nozzles 4a and 4b simultaneously by running the ink carriage 5 once, after which the recording paper 2 is transported by one running width (S45).

Then, whether the printing of one page is completed or not is judged (S46), and if not, the flow returns to S45, and S45 and S46 are repeated until the printing is completed.

When the printing is completed in S46, the recording paper 2 is released (47).

If there is data for a following page when the printing on the recording paper 2 is completed (S48), the flow returns to S41, and S41-S48 are repeated.

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By carrying the foregoing steps, print with the resolution two times greater can be made.

As has been discussed, according to the ink jet printer of the present embodiment, each group of the back ink nozzles 4b and front ink nozzles 4a facing their respective directions along the transportation direction of the recording paper 2 is provided with a plurality of ink holes aligned in a line slanted with respect to the main running direction along the supporting axis 1 and the transportation direction of the recording paper 2 for each color. In addition, the plurality of ink holes for the same color in each group of the back ink nozzles 4b and front ink nozzles 4a facing their respective directions are shifted by half the pitch with respect to each other as to the intervals among the ink nozzles in the running direction along the supporting axis 1.

For this reason, the first printing is effected by the back ink nozzles 4b facing one direction, and the second printing is effected by the front ink nozzles 4a facing another direction by shifting the intervals in the running direction along the supporting axis 1 half the pitch, so that the second print is superimposed on the first print. Accordingly, resolution and printing density in the running direction along the supporting axis 1 can be increased twice.

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Consequently, there can be provided an ink jet printer which can improve printing efficiency by improving printing resolution, etc.

It should be appreciated that the present invention is not limited to the above embodiment and can be modified in various manners within the scope of the present invention. For example, in the above embodiment, the holes of the front ink nozzles 4a and back ink nozzles 4b are of the identical size. However, the size of the ink nozzles can be changed.

For example, as shown in Figure 17(b), the diameter of the ink drop from the back ink nozzles 4b of the back ink head 7 of the ink tank 3 provided on the ink carriage 5 may be arranged in order of "large", "small", "large", "small",

On the other hand, as shown in Figure 17(a), the diameter of the ink drop from the front ink nozzles 4a of the front ink head 6 on the ink tank 3 provided on the ink carriage 5 may be arranged in order of "small", "large", "small", "large",

The ink drop of the large or small diameter can be formed by changing the size of the ink nozzle holes, or alternatively can be formed from the ink nozzles holes of the same size by changing a quantity of ink to be dropped.

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When the printing is effected by such an ink drop alignment, as shown in Figure 18(a), print data in the odd-numbered columns are printed out by the back ink nozzles 4b of the back ink head 7. Here, in case of the back ink head 7 shown in Figure 17(b), the print data to be printed out from top to bottom on the recording paper 2 is assigned to the back ink nozzles 7b from bottom to top, and therefore, in Figure 18(a), the print is upside down.

Then, as shown in Figure 18(b), print data of the even-numbered columns is printed out by the front ink nozzles 4a by the front ink head 6. By superimposing the printing of the odd-numbered columns and the printing of the even-numbered columns, spaces between dots of a larger diameter are filled with dots of a smaller diameter as shown in Figure 18(C), thereby making it possible to obtain the print data at high resolution and density.

As has been discussed, according to the ink jet printer of the present embodiment, the ink holes of the back ink nozzles 4b and those of the front ink nozzles 4a facing their respective directions along the transportation direction of the recording paper 2 are shifted by half the pitch with respect to each other as to the intervals in the running direction along the

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supporting axis 1. Also, for example, the diameter of the ink drops from the back ink nozzles 4b may be changed in order of large and small in alternation, and the diameter of the ink drops from the front ink nozzles 4a may be changed in order of small and large in alternation.

According to the above arrangement, after the first printing by the back ink nozzles 4b is completed, the second printing by the front ink nozzles 4a is effected in such a manner that it is shifted by half the pitch in the scanning direction and dot spaces in the first printing are filled with the front ink nozzles 4a. Consequently, the resolution in the running direction can be increased two times and the printing density can be increased.

In short, compared with a case where the printing is effected by one group of ink nozzles, the printing is effected without leaving dot spaces.

In the present embodiment, the print of the odd-numbered columns and the print of the even-numbered columns are superimposed with respect to the running direction. However, the arrangement is not limited to the foregoing, and the print made by the front ink nozzles 4a can be superimposed on the print made by the back ink head 7 in the sub-running direction, that is, in

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the transportation direction of the recording paper 2.

To be more specific, as shown in Figures 19(a) and 19(b), the front ink nozzles 4a of the front ink head 6 are assigned to the odd-numbered rows, and the back ink nozzles 4b of the back ink head 7 are assigned to the even-numbered rows, and the dividing pitch is shifted by half the pitch with respect to the print resolution in the transportation direction of the recording paper 2.

When the printing is effected with the foregoing nozzle assignment, as shown in Figure 20(a), print data of the odd-numbered rows is printed out by the back ink nozzles 4b, and then, as shown in Figure 20(b), print data of the even-numbered rows is printed out by the front ink nozzles 4a. Accordingly, the print of the odd-numbered rows and the print of the even-numbered rows are superimposed one on the other, and as shown in Figure 20(c), print data with its resolution increased twice in the sub-running direction can be obtained.

As has been discussed, in the ink jet printer of the present embodiment, each group of the back ink nozzles 4b and front ink nozzles 4a facing their respective directions along the transportation direction of the recording paper 2 includes a plurality of ink holes aligned in a line slanted with respect to the running direction along the supporting axis 1 and the

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transportation direction of the recording paper 2 for the respective colors. Also, the ink holes of the back ink nozzles 4b and those of the front ink nozzles 4a of the same color are shifted by half the pitch with respect to each other as to the interval in the transportation direction of the recording paper 2.

Hence, the first printing is effected by the back ink nozzles 4b facing one direction, and the second printing is effected by the front ink nozzles 4a facing another direction by shifting the intervals in the transportation direction of the recording paper 2 half the pitch, so that the second print is superimposed on the first print. Accordingly, resolution and printing density in the transportation direction of the recording paper 2 can be increased twice.

Consequently, an ink jet printer which can improve printing efficiency by improving printing resolution, etc. can be provided.

Also, as shown in Figures 21(a), 21(b), and 21(c), the front ink nozzles 4a of the front ink head 6 and the back ink nozzles 4b of the back ink head 7 may be assigned with the odd-numbered columns and rows, and even-numbered columns and rows, respectively.

In this case, half the pitch with respect to the printing resolution in the main running direction of the

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ink carriage 5 is given as the dividing pitch, while half the pitch with respect to the printing resolution in the transportation direction of the recording paper 2 is also given as the dividing pitch.

When the printing is effected with such a nozzle assignment, as shown in Figure 22(a), a matrix (odd number matrix) composed of the odd-numbered columns and rows is printed out by the back ink nozzles 4b first, and thence, as shown in Figure 22(b), a matrix (even number matrix) composed of the even-numbered columns and rows is printed out by the front ink nozzles 4a. Consequently, the even number matrix is superimposed on the odd number matrix, and as shown in Figure 22(c), print data with resolution and density increased twice both in the main running direction and sub-running direction can be obtained.

As has been discussed, according to the ink jet printer of the present embodiment, each group of the back ink nozzles 4b and front ink nozzles 4a facing their respective directions along the transportation direction of the recording paper 2 includes a plurality of ink holes aligned in a line slanted with respect to the running direction along the supporting axis 1 and the transportation direction of the recording paper 2 for the respective colors. In addition, the plurality of ink

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nozzle holes aligned for each color in each group of the back ink nozzles 4b and front ink nozzles 4a facing their respective directions are shifted with respect to each other by half the pitch as to the intervals in the running direction along the supporting axis 1 and the transportation direction of the recording paper 2.

Hence, by effecting the first printing by the back ink nozzles 4b facing one direction, and the second printing by the front ink nozzles facing another direction by shifting the intervals both in the scanning direction along the supporting axis 1 and the intervals in the transportation direction of the recording paper 2 so as to be superimposed on the print made by the first printing, the resolution and printing density both in the scanning direction along the supporting axis 1 and the intervals in the transportation direction of the recording paper 2 can be increased twice.

Consequently, an ink jet printer which can improve printing efficiency by improving printing resolution, etc. can be provided.

Further, the diameter of the ink drop is the same in the above embodiment, but the diameter can be changed.

More specifically, as shown in Figures 23(a), 23(b), and 23(c), the front ink nozzles 4a of the front ink head 6 and the back ink nozzles 4b of the back ink head 7 are

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assigned to the printing of odd-numbered columns and row, and the printing of the even-numbered columns and rows, respectively. Also, the dividing pitches are shifted to each other by half the pitch for the printing resolution both in the main running direction of the ink carriage 5 and the transportation direction of the recording paper 2, that is, the sub-running direction.

The diameter of the ink drop for the back ink nozzles 4b that print out the odd-numbered columns and rows is made smaller than the diameter of the ink drop for the front ink nozzles 4a that print out the even-numbered columns and rows.

When the printing is effected with such a nozzle assignment, as shown in Figure 24(a), a matrix of the odd-numbered rows columns (odd number matrix) is printed out by the back ink nozzles 4b first, and then, as shown in Figure 24(b), a matrix of the even-numbered rows and columns (even number matrix) is printed out by the front ink nozzles 4a. Accordingly, the even number matrix is superimposed on the odd number matrix, and as shown in Figure 24(c), spaces among the larger dots are filled with the smaller dots both in the main running direction and sub-running direction, thereby making it possible to obtain print data at higher resolution and higher density.

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to superimpose on the print made by the first printing, the resolution and printing density both in the scanning direction along the supporting axis 1 and the intervals in the transportation direction of the recording paper 2 can be increased twice.

In addition, by superimposing the first print and second print so as to fill the spaces among dots on the first print, the resolution and density can be increased both in the running direction and paper transportation direction.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by improving printing resolution, etc.

(Embodiment 4)

Referring to Figures 25 and 26, the following description will describe still another embodiment of the present invention. Hereinafter, like components are labeled with like reference numerals with respect to Embodiments 1-3, and the description of these components is not repeated for ease of explanation.

According to an ink jet printer of the present embodiment, a watermark is printed out on one recording paper 2 as first print data by the back ink nozzles 4b, one of the two groups of ink nozzles provided on the ink

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Then, whether the recording paper 2 has reached the printing position of the front ink nozzles 4a or not is checked (S55). If not, the flow returns to S54 and S54-S55 are repeated until the recording paper 2 reaches the printing position of the front ink nozzles 4a.

Then, whether the watermark and the data of one page have been printed out or not is judged (S57). If not,

When it is judged in S57 that the data of one page is completed, the recording paper 2 is released (S58).

Then, whether there is any following data or not is judged (S59), and if there is no following data, the job is completed. Otherwise, the flow returns to S52 and S52-S59 are repeated.

By carrying out the above procedure, the printing time can be shortened and the cost can be saved.

As has been discussed, according to the ink jet printer of the present embodiment, the first print data, such as a watermark, is printed out by the back ink nozzles 4b, one of the two groups of ink nozzles facing their respective directions, while the second print data of a different kind from the first print data, such as text information, is printed out by the other front ink nozzles 4a.

In other words, the first print data, such as a watermark, is printed out on one recording paper 2 by the back ink nozzles 4b, one of the two groups of ink nozzles facing their respective directions, and then the second print data, such as text information, is printed out by the other front ink nozzles 4a on the same recording paper.

Consequently, mixed recording information can be printed out simultaneously by transporting the recording paper 2 once. In other words, image data can be printed out with appended data.

Consequently, there can be provided an ink jet printer which can improve a printing efficiency by accelerating the printing time including the paper transporting time and realizing simultaneously printing of mixed information.

In addition, in the present embodiment, the image information is printed out by using either the back ink nozzles 4b or front ink nozzles 4a only when a print request is issued.

Consequently, the image information can be printed out by using one of the back ink nozzles 4b and front ink nozzles 4a at a print request, while at the same time, for example, printing out appended information by the other ink nozzles.

In addition, in the present embodiment, appended information can be printed out by the other ink nozzles, for example.

Consequently, the print data at request and appended information can be printed out in a reliable manner on the same recording paper 2 by transporting the same once.

In addition, in the present embodiment, the appended

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(Embodiment 5)

Referring to Figures 27 through 37, the following description will describe still another embodiment of the present invention. Hereinafter, like components are labeled with like reference numerals with respect to Embodiments 1-4, and the description of these components is not repeated for ease of explanation.

An ink jet printer of the present embodiment is an ink jet printer having two groups of ink nozzles for one ink tank and provided with mechanism that realizes switchback of one recording paper between the two groups of ink nozzles, whereby printing is effected on both the front and back surfaces of the recording paper by the two groups of ink nozzles, respectively.

In other words, according to the ink jet printer of the present embodiment, as shown in Figure 27, a switchback path mechanism 40 as paper reversing means for realizing the double-side printing of the recording paper 2 is provided below the ink carriage 5.

The switchback path mechanism 40 comprises a pair of back ink nozzle rollers 43 and a pair of front ink nozzles rollers 45 provided below the ink carriage 5 for transporting the recording paper 2, a paper guide 42 extending downward somewhere between the pair of back ink nozzle rollers 43, and the pair of the front ink nozzle

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rollers 45, a pair of paper direction switching rollers 44 provided below the paper guide 42 and capable of rotating in either direction, and a switchback case 41.

The pair of the back ink nozzle rollers 43 are rollers to transport the recording paper 2 to the switchback case 41 after print is made on the front surface thereof by the back ink nozzles 4b. Thus, the pair of the front ink nozzle rollers 43 is provided below the ink carriage 5 on the side where the back ink nozzles 4b are provided.

In addition, the pair of front ink nozzle rollers 45 are the rollers that transport the recording paper 2 toward the front ink nozzles 4a, so that print will be made on the back surface of the recording paper 2 on which print has been made by the back ink nozzles 4b at the front surface. Thus, the pair of front ink nozzle rollers 45 are provided below the ink carriage 5 on the side where the front ink nozzles 4a are provided, so that the recording paper 2 transported from the paper guide 42 is transported further to the front ink nozzles 4a.

On the other hand, as shown in Figure 28, the paper guide 42 is provided with a paper guide rotating axis 46 at substantially the middle in the vertical direction, so that the paper guide 42 is allowed to rotate around the paper guide rotating axis 46 by an unillustrated solenoid

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or the like.

Thus, the recording paper 2 having passed through a space between the pair of the back ink nozzle rollers 43 is transported to the pair of paper direction switching rollers 44 with its top end sliding along the paper guide 42, whereby, as shown in Figure 29, the recording paper standing upright is stored in the switchback case 41.

Then, when the printing is effected by the front ink nozzles 4a on the back surface of the recording paper 2, the paper guide 42 is tilted toward the pair of front ink nozzle rollers 45 with respect to the paper guide rotating axis 46 as shown in Figure 30.

Subsequently, the recording paper 2 stored in the switchback case 41 is moved vertically by rotating the pair of paper direction switching rollers 44 in a reverse direction. Then, the latter end of the recording paper 2, that is, the top end of the recording paper 2 in the transportation direction is guided as it slides along the paper guide 42. Hence, the recording paper 2 passes by a space between the pair of front ink nozzle rollers 45 to reach the printing position of the front ink nozzles 4a, whereupon the printing is effected on the back surface of the recording paper 2 by the front ink nozzles 4a.

In this case, the characters printed out by the back

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ink nozzles 4b and those printed out by the front ink nozzles 4a are upside down with each other. However, this can be prevented by using an adequate software program.

Here, as shown in Figure 31, the switchback path mechanism 40 is arranged in such a manner that, when the print data is printed out on the both sides of more than one recording paper 2, the printing can be effected simultaneously on the back surface of the first recording paper 2a and the front surface of the second recording paper 2b by the two groups of ink nozzles 4a and 4b, respectively.

In other words, when data of more than one page is printed out, the printing is effected on the second recording paper 2b by the back ink nozzles 4b and on the first recording paper 2a by the front ink nozzles 4a simultaneously, thereby making it possible to increase the printing rate.

The double-side printing operation of the above-arranged ink jet printer will be explained with reference to the flowchart of Figure 32.

Initially, the ink jet printer receives data of one page, and stores the same in the back ink nozzle print memory (S61). Then, whether there is any recording paper 2 in the switchback case 41 or not is judged (S62). If

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not, a new recording paper 2 is transported to the printing position of the back ink nozzles 4b (S63).

Then, the data is sent to the back ink nozzles 4b from the back ink nozzle print memory to be printed out on the front surface of the recording paper 2 (S64).

Subsequently, the recording paper 2 is transported into the switchback case 41 after print is made on the front surface thereof (S65).

Then, whether there is any following data or not is judged (S66), and if not, the recording paper 2 in the switchback case 41 is released (S76).

On the other hand, when there is data of the following page, the ink jet printer receives data of one page of the back surface and stores the same in the front ink nozzle memory (S67).

Then, whether there is any following data or not is judged (S68), and if not, the recording paper 2 in the switchback case 41 is transported to the printing position of the front ink nozzles 4a (S69). Subsequently, the data is sent to the front ink nozzles 4a from the front ink nozzle print memory, and the data is printed out on the back surface of the recording paper 2 (S70). When the printing on the back surface of the recording paper 2 ends, the recording paper 2 is released (S71).

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Then, the flow moves to S66, where whether there is any data of a following page or not is judged, and when there is data, S66-S71 and S61-S62, and S72-S75 are

repeated.

By the above procedure, the double-side printing on more than one recording paper 2 can be effected in a shorter time.

As has been discussed, according to the ink jet printer of the present embodiment, the switchback path mechanism 40 for reversing the surface of the recording paper 2 is provided on the transportation path of the recording paper 2 somewhere between the back ink nozzles 4b and front ink nozzles 4a facing their respective directions.

Thus, the double-side printing can be effected by effecting the printing on the front surface of the recording paper 2 by the back ink nozzles 4b, one of the two groups of ink nozzles facing their respective directions, then turning over the recording paper 2 by the switchback path mechanism 40, and effecting the printing on the back surface of the recording paper 2 by the other front ink nozzles 4a.

In addition, the mechanism for the double-side printing effects the printing on the recording paper 2 by using the back ink nozzles 4b and front ink nozzles 4a facing their respective directions while the recording paper 2 is transported through the single transportation path. Thus, the recording paper 2 only has to be turned

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over somewhere between the back ink nozzles 4b and front ink nozzles 4a. As a result, the switchback path mechanism can be simplified.

In addition, compared with a conventional case where the double-side printing is effected on the recording paper 2 by the ink nozzles facing only one direction, according to the present embodiment, the printing is effected on the front surface of the recording paper 2 by the back ink nozzles 4b, one of the two groups of ink nozzles facing their respective directions, while at the same time the printing is effected on the back surface of the preceding recording paper 2 by the other ink nozzles 4a. Consequently, when the double-side printing is effected on more than one recording paper 2, the time required for the double-side printing can be reduced to half the conventionally required time.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by improving printing resolution, etc.

According to the switchback path mechanism 40 of the present embodiment, the paper guide 42 serving as a transportation changing guide is provided in the transportation path the recording paper 2 passes through after the printing is effected thereon by the back ink nozzles 4b, so that the transportation path is changed

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for the turned over recording paper 2. Accordingly the turned over recording paper 2 is transported to the printing position of the front ink nozzles 4a, and the printing is effected on the back surface thereof by the front ink nozzles 4a.

Since the printing can be effected on both the sides of the recording paper 2 by transporting the recording paper 2 through a single transportation path only once, the double-side printing time can be shortened. In addition, for example, by controlling the operation of the paper guide 42 independently, the transportation path can be changed accurately.

It should be appreciated that the present invention is not limited to the foregoing embodiments, and can be modified in various manners within the scope thereof. For example, in the above embodiment, the paper guide 42 changes its direction when rotated by the paper guide rotating axis 46 driven by an unillustrated motor. However, the arrangement is not limited to the foregoing, and the direction of the paper guide 42 can be changed by a solenoid or the like.

More specifically, according to a switchback path mechanism 50 shown in Figure 33, a paper direction switching guide 51 having a triangular cross section is provided prior to the pair of the paper direction

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switching rollers 44 formed in the vicinity of the inlet/outlet of the switchback case 41.

The paper direction switching guide 51 changes the direction of the recording paper 2 by a solenoid 52 provided above, for example.

To be more specific, the printing is effected by the back ink nozzles 4b on one surface of the recording paper 2 transported in the direction indicated by an arrow A in the drawing. Then, the recording paper 2 is transported near the pair of paper direction switching rollers 44 by the pair of back ink nozzles rollers 43.

During this operation, the solenoid 52 remains OFF, and the paper direction switching guide 51 is positioned as indicated by an alternate long and short dash line in the drawing, so that the recording paper 2 is transported into the switchback case 41 through a space between the pair of paper direction switching rollers 44.

Subsequently, the recording paper 2 is transported further in the direction indicated by an arrow B by the pair of paper direction switching rollers 44 until it is stored in the switchback case 41 entirely. After the recording paper 2 is stored entirely in the switchback case 41, the solenoid 52 linked to the paper direction switching guide 51 is switched ON, and moves in the direction indicated by an arrow E. Then, the paper

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direction switching guide 51 linked to the solenoid 52 moves in association, and the transportation path is changed as indicated by a solid line in the drawing.

After the paper direction switching guide 51 changed the transportation path, the pair of paper direction switching rollers 44 start to rotate in a reverse direction, whereby the recording paper 2 is transported in the direction indicated by an arrow C until it reaches the pair of front ink nozzle rollers 45. Then, the recording paper 2 is transported further in the direction indicated by an arrow D by the pair of front ink nozzle rollers 45. Thus, after the printing is effected on the back surface of the recording paper 2 by the front ink nozzles 4a, the recording paper 2 is released.

As has been discussed, according to the switchback path mechanism 50 of the present embodiment, by providing the paper direction switching guide 51 as the transportation changing guide in the transportation path the recording paper 2 passes through after the printing is effected thereon by the back ink nozzles 4b, and controlling the paper direction switching guide 51 by means of the solenoid 52, the recording paper 2 is turned over while the paper direction is reversed.

Consequently, because the paper direction switching guide 51 is switched by the solenoid 52, the recording

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paper 2 can be turned over while the paper direction is reversed in a reliable manner.

In the switchback path mechanism 50, the paper direction switching guide 51 is switched by the solenoid 52 in the above explanation. However, the arrangement is not limited to the foregoing. For example, the solenoid 52 can be replaced with a spring.

More specifically, as shown in Figure 34, a switchback path mechanism 60 is provided with a spring 61 instead of the solenoid 52. The spring 61 constantly opens the transportation path, so that the paper direction switching guide 51 guides the recording paper 2 contained in the switchback case 41 to be transported toward the pair of the front ink nozzle rollers 45.

Thus, according to the switchback path mechanism 60, the printing is effected by the back ink nozzles 4b on one surface the recording paper 2 transported in the direction indicated by an arrow A, after which the recording paper 2 is transported forward by the pair of back ink nozzle rollers 43. Here, a force is constantly applied on the paper direction switching guide 51 provided in the transportation path in the direction indicated by an arrow E from the contracted spring.

However, the force produced by the spring 61 is so weak that, against that force, the paper direction

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nozzles 4a, the recording paper 2 is released.

As has been discussed, according to the switchback path mechanism 60 of the present embodiment, the paper direction switching guide 51 serving as the transportation path changing guide is provided in the transportation path the recording paper 2 passes through after print is made thereon by the back ink nozzles 4b in such a manner that the transportation path is closed constantly by the same by using thrusting means, such as the spring 61. The recording paper 2 is transported in such a manner so as to push aside the paper direction switching guide 51 against a thrust from the paper direction switching guide 51, and after the recording paper 2 passed by the paper direction switching guide 51, the recording paper 2 is turned over and changes the transportation path, through which the recording paper 2 is transported to the printing position of the front ink nozzles 4a so that the printing is effected on the back surface thereof.

Consequently, because the printing is effected on both the surfaces of the recording paper 2 by transporting the same only once through the single transportation path, the time required for the double-side printing can be shortened. In addition, the paper direction switching guide 51 changes the transportation

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Incidentally, in the foregoing switchback path mechanisms 40, 50, and 60, the paper guide 42 and paper direction switching guide 51 are operated by the motor, solenoid 52, and spring 61. However, the arrangement is not limited to the foregoing, and these components can be omitted if desired.

More specifically, the printing is effected on one surface of the recording paper 2 sent in the direction indicated by an arrow A by the back ink nozzles 4b, and the recording paper 2 is forwarded by the pair of ink nozzle rollers 43.

According to the switchback path mechanism 70, by giving an angle to the transportation path, the recording paper 2 is transported in the direction indicated by an arrow B. When the top end of the recording paper 2 touches a pair of the paper direction switching rollers 72, the recording paper 2 is transported by the pair of paper direction switching rollers 72 in such a manner

When the entire recording paper 2 is stored in the switchback case 71, the pair of paper direction switching rollers 72 start to rotate in a reverse direction. Because the recording paper 2 has some hardness, the recording paper 2 is not transported in the direction indicated by an arrow D, but in the direction indicated by an arrow E. When the recording paper 2 reaches the pair of the front ink nozzle rollers 45, it is transported in the direction indicated by an arrow F by the pair of front ink nozzle rollers 45. Then, after the printing is effected on the back surface of the recording paper 2 by the front ink nozzles 4a, the recording paper 2 is released.

Since the printing can be effected on both the sides of the recording paper 2 by transporting the recording paper 2 through a single transportation path only once, the double-side printing time can be shortened. Further,

because the solenoid 52, spring 61, etc. are omitted when changing the transportation path by the paper direction switching guide 51, the arrangement can be simplified and the cost can be saved.

On the other hand, according to the switchback path mechanism 70, the pair of paper direction changing rollers 72 and switchback case 71 are not necessarily tilted when switching back the recording paper 2.

In other words, as shown in Figure 36, according to a switchback path mechanism 80, the switching back case is provided upright, while the pair of paper direction switching rollers 81 and 82 are provided horizontally.

It should be noted, however, that a switching path 83 for switching the transportation path from the one in the direction indicated by the arrow A and to the one in the direction indicated by the arrow D is provided directly above the pair of the paper direction switching rollers 81 and 82.

The switching path 83 comprises a front guide 83a supported by an roller axis 81a of the paper direction switching roller 81 provided in the front transportation path end, that is, in the direction indicted by the arrow D so as to be rotatable, a back guide 83b supported by a rotation axis 84 provided directly above the paper direction switching roller 82 at the back transportation

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paper 2 contained in the switchback case 41 through the front transportation path in the direction indicated by the arrow D, the pair of paper direction switching rollers 81 and 82 are rotated in the direction such that the recording paper 2 is released. Hence, the paper direction switching roller 81 rotates counterclockwise, so does the front guide 83a supported by the roller axis 81a of the paper direction switching roller 81 in association. Accordingly, the back guide 83b starts to rotate counterclockwise with respect to the rotating axis 84 through the link bar 85.

Consequently, the switching path 83 is switched to connect the switchback case 41 to the front transportation path as is indicated by an alternate long and short dash line in the drawing. Thus, the recording paper 2 transported in the direction indicted by the arrow D passes through the switching path 83 and is contained in the switchback case 41.

The front guide 83a supported by the roller axis 81a of the paper direction switching roller 81 rotates either clockwise or counterclockwise in association with the rotation of the paper direction switching roller 81. However, once the switching path 83 is set to the desired switching position, the paper direction switching roller 81 keeps rotating, but the front guide 83a does not

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rotate any further.

The concrete operation of the switchback path mechanism 80 from the start is detailed in Figure 36. Initially, the recording paper 2 is transported in the direction indicated by the arrow A, and the printing is effected one surface of the same by the front ink nozzles 4a. Then, when the printing ends, the recording paper 2 is transported to the switchback case 41 provided below by the pair of back ink nozzle rollers 43. The pair of paper direction switching rollers 81 and 82 provided directly above the switchback case 41 rotate in the direction such that the recording paper 2 is stored in the switchback case 41, whereby the paper direction switching roller 81 rotates clockwise. Thus, the front guide 83a starts to rotate clockwise with respect to the roller axis 81a in association with the rotation of the paper direction switching roller 81, whereupon the back guide 83b starts to rotate clockwise with respect to the rotating axis 84 through the linking bar 85.

Consequently, the switching path 83 is switched such that the back transportation path is connected to the switchback case 41, whereby the recording paper 2 passes through the switching path 83 and touches the pair of paper direction switching rollers 81 and 82. Then, the recording paper 2 is stored in the switchback case 41 by

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Consequently, the printing can be effected on both the surfaces of the recording paper 2 by transporting the same through the single transportation path only once, thereby making it possible to shorten the time required for the double-side printing. In addition, because the transportation path is changed by moving the switching path 83 with a driving force of the pair of paper direction switching rollers 81 and 82 when turning over the recording paper 2. Hence, the transportation path can be changed by a simple arrangement in a reliable manner.

Further, still another switchback path mechanism 90 is available.

In other words, the pickup roller 92b, one of the pickup rollers 92a and 92b that touches the surface of the recording paper 2 facing upward, includes an arm 93 which is allowed to rotate around an end portion axis 93a.

Thus, when the recording papers 2 are piled, the pickup roller 92b is in the stand-by position indicated by a solid line in the drawing. On the other hand, when picking up the recording paper 2 piled in the stack tray 91, the arm 93 rotates around the end portion axis 93b, whereby the pickup roller 92b starts to rotate in the direction indicated by the arrow B and moves to a position indicated by an alternate long and short dash line, so that the recording paper 2 is sandwiched by the pair of the pickup rollers 92a and 92b. Then, when the pair of pickup rollers 92a and 92b start to rotate under these conditions, the recording paper 2 is picked up and transported in the direction indicated by the arrow D.

surface by the back ink nozzles 4b and then picked up separately, the recording paper 2 can be transported to the front ink nozzles 4a so that print is made on its back surface by the same.

Consequently, the printing can be effected on both the surfaces of the recording paper 2 by transporting the same through a single transportation path only once, thereby making it possible to shorten the time required for the double-side printing. In addition, because more than one recording paper 2 can be piled in the stack tray 91, an arbitrary time interval can be set between the first and second recording papers 2. Consequently, the double-side printing rate from the second page can be accelerated further.

(Embodiment 6)

Referring to Figures 38-40, the following description will describe still another embodiment of the present invention. Hereinafter, like components are labeled with like reference numerals with respect to Embodiments 1-5, and the description of these components is not repeated for ease of explanation.

An ink jet printer of the present embodiment is any of the ink jet printers of Embodiments 1-5 additionally provided with a drier device.

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To be more specific, as shown in Figure 38, the ink jet printer of the present embodiment is identical with the counterpart of Embodiment 1 except that a back drier device 95 is additionally provided at the position the recording paper 2 passes immediately after the printing is effected thereon by the back ink nozzles 4b, and a front drier device 96 is additionally provided at the position the recording paper 2 passes immediately after the printing is effected thereon by the front ink nozzles 4a.

Each of the front drier device 95 and back drier device 96 extends along the width direction of the recording paper 2, and is in the form of a bar provided in the vicinity of the recording paper 2.

Each of the bars of the back drier device 95 and front drier device 96 encloses a heater, for example, so that the heater is heated by allowing a current to flow through the same to dry the recording paper 2 when it passes by the back drier device 95 and front drier device 96.

When the back drier device 95 is not provided as shown in Figure 5, after the printing by the back ink nozzles 4b, the recording paper 2 is transported toward the front ink nozzles 4a by the pair of paper length adjusting rollers 8. However, the latter half of the

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However, if the back drier device 95 is provided, the latter half of the recording paper 2 passes through a space between the pair of paper length rollers 8 after the print made thereon is dried.

On the other hand, as shown in Figure 39, the ink jet printer having the switchback path mechanism 40 of Embodiment 4 can be also provided with a back drier device 97 at the position the recording paper 2 passes

immediately after the printing is effected thereon by the back ink nozzles 4b, and a front drier device 98 at the position the recording paper 2 passes immediately after the printing is effected thereon by the front ink nozzles 4a.

Accordingly, after the printing is effected by the back ink nozzles 4b and the print is dried by the back drier device 97, the recording paper 2 passes through a space between the pair of back ink nozzle rollers 43 and is stored in the switchback case 41.

The recording paper 2 is turned over and transported from the switchback case 41, and after the printing is effected on the back surface by the front ink nozzles 4a, the print is dried by the front drier device 98.

When the recording paper 2 is dried by the front drier device 98, the recording paper 2 is already heated because the other surface is already dried by the back drier device 97. Thus, the drying of the recording paper 2 by the front drier device 98 consumes less power than the drying of the recording paper 2 by the back drier device 97.

If the front drier device 97 is provided to the ink jet printer having the switchback path mechanism 40, a cylindrical roller can be used as each of the pair of back ink nozzle rollers 43 and front ink nozzle rollers

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To be more specific, when the printing is effected on one recording paper 2 sequentially by the back ink nozzles 4b and front ink nozzles 4a facing their respective directions in a short time, if the printing is effected by the front ink nozzles 4a when the print made by the other back ink nozzles 4b is not dried well, smear of the ink may occur or the ink adhered to the transportation roller or the like dirties the recording paper 2.

Hence, after the printing is effected by the ink nozzles 4b first, the printed portion is dried by the back drier device 95, 97, or 99.

For this reason, unwanted smear of the ink or the inconveniences such that the ink adhered to the transportation roller or the like dirties the recording paper 2 can be prevented, because by the time the printing is effected by the front ink nozzles 4a, the print made by the preceding printing effected by the back

ink nozzles 4b is already dried.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by increasing the printing rate and printing resolution, and realizing the printing of an overstrike character, simultaneous printing of mixed information, double-side printing, etc.

In the present embodiment, the back drier device 95, 97, or 97 is provided at least somewhere between the back ink nozzles 4b and front ink nozzles 4a as drying means. However, the drying means is not limited to the foregoing, and can be the front drier device 96 or 98.

More specifically, according to the present embodiment, the ink jet printer having two groups of back ink nozzles 4b and front ink nozzles 4a facing their respective directions is provided with the back drier device 95, 97, 99 for drying the print made on the recording paper 2 by the back ink nozzles 4b, and the front drier device 96 or 98 for drying the print made on the recording paper 2 by the front ink nozzles 4a.

Consequently, print made on each of the front and back surfaces of the recording paper 2 can be dried, thereby making it possible to increase the printing rate and efficiency. In addition, because a set of cylindrical rollers can be used as the pair of paper

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length adjusting rollers 8, the transportation rate can be increased. Further, because the print is dried by both the back drier device 95, 97, or 99 and the front drier device 96 or 98, drying efficiency can be increased.

In addition, the back drier device 97 of the present embodiment is provided somewhere between the back ink nozzles 4b and front ink nozzles 4a, and somewhere between the back ink nozzles 4b and the switchback case 41.

Consequently, the print made on one surface of the recording paper 2 by the back ink nozzles 4b can be dried in a reliable manner before the following printing is effected.

In addition, the back drier device 99 of the present embodiment is provided somewhere between the back ink nozzles 4b and front ink nozzles 4a after the switchback case 41, and the front drier device 98 of the present embodiment is provided after the front ink nozzles 4a.

Thus, both the front and back surfaces of the recording paper 2 can be dried during the double-side printing. In addition, because the recording paper 2 is dried by the back drier device 99 by the time the printing is effected by the front ink nozzles 4a, the print made by the front ink nozzles 4a can be readily

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In addition, according to the present embodiment, the ink jet printer having the switchback path mechanism 40, 50, 60, 70, 80, or 90 is provided with the back drier device 97 or 99 for drying print made on the recording paper 2 at least somewhere between the two groups of back ink nozzles 4b and front ink nozzles 4a facing their respective directions on the transportation path of the recording paper 2.

For this reason, unwanted smear of the ink or the inconveniences such that the ink adhered to the transportation roller or the like dirties the recording paper 2 can be prevented, because by the time the printing is effected by the front ink nozzles 4a, the print made by the preceding printing effected by the back ink nozzles 4b is already dried.

Consequently, there can be provided an ink jet printer having the switchback path mechanism 40, 50, 60, 70, 80, or 90, and capable of improving printing efficiency by increasing a printing rate and realizing



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smaller than the predetermined power when the double-side printing is effected.

In other words, in case of the double-side printing, when the time the front drier device 96 or 98 dries the print, there is remaining heat on the recording paper 2 from the drying by the back drier device 96 or 99 of the print made by the back ink nozzles 4b. Thus, the front drier device 96 or 98 consumes less power than the predetermined power source for the drying operation.

Consequently, overall power consumption can be saved.

Also, according to the present embodiment, in the ink jet printer having the switchback path mechanism 40, 50, 60, 70, 80 or 90, the back drier device 97 for drying print made on the recording paper 2 by the front ink nozzles 4b is provided before the pair of the back ink nozzle rollers 43 prior to the switchback path mechanism 40, 50, 60, 70, 80, or 90.

Consequently, the print made on the recording paper 2 by the back ink nozzles 4b can be dried before the recording paper 2 is transported to the switchback path mechanism 40, 50, 60, 70, 80 or 90.

Also, according to the present embodiment, in the ink jet printer having the switchback path mechanism 40, 50, 60, 70, 80, or 90, the back drier device 97 for

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drying print made on the recording paper 2 by the back ink nozzles 4b is provided before the pair of the back ink nozzle rollers 43 prior to the switching back path mechanism 40, 50, 60, 70, 80, or 90, and a pair of cylindrical rollers are used as each pair of the back ink nozzles rollers 43 and front ink nozzle rollers 45.

In other words, the print made on the recording paper 2 by the back ink nozzles 4b is dried by the back drier device 97 provided before the pair of back ink nozzle rollers 43. Thus, a conventionally used star roller is replaced with a cylindrical roller having a larger transportation force than the star roller. Consequently, the transportation efficiency can be increased and the printing effect can be enhanced.

According to the present embodiment, in the ink jet printer having (1) the switching back path mechanism 40, 50, 60, 70, 80, or 90, (2) the back drier device 99 for drying print made on the recording paper 2 by the back ink nozzles 4b, and (3) the front drier device 98 for drying print made on the recording paper 2 by the front ink nozzles 4a, in order to dry the print made on the recording paper 2 by the back ink nozzles 4b, the back drier device 99 is provided before the printing position of the front ink nozzles 4a behind the pair of the front ink nozzle rollers 45 immediately after the switchback

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An ink jet printer of the present invention is an

ink jet printer which makes print on a recording paper by running an ink carriage along a supporting axis in a reciprocating motion, characterized in that the ink carriage includes ink heads each provided with an ink nozzle facing a different direction, so that printing is effected on the recording paper simultaneously at more than one portion along a transportation direction in which the recording paper is transported through a single transportation path one by one.

According to the above invention, the ink carriage includes the ink heads each provided with an ink nozzle facing a different direction, so that printing is effected on the recording paper simultaneously at more than one portion along a transportation direction in which the recording paper is transported through a single transportation path one by one.

Hence, print can be made simultaneously at more than one portion on the same recording paper by running one ink carriage. Thus, when the printing is effected simultaneously at more than one portion along the transportation direction of the recording paper in monochrome, the printing time can be shortened compared with an ink head provided with an ink nozzle facing only direction.

In addition, by allocating print data to each group

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of the ink nozzles facing their respective directions, an overstrike character can be printed out, printing resolution can be improved, and mixed information can be recorded by transporting the recording paper only once. Further, the double-side printing can be effected by providing a switchback path mechanism.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by increasing a printing rate and printing resolution, and realizing printing of an overstrike character, simultaneous printing of mixed information, double-side printing, etc.

Another ink jet printer of the present invention is an ink jet printer which makes print on a recording paper by running an ink carriage along a supporting axis in a reciprocating motion, characterized in that the ink carriage includes two ink heads each provided with an ink nozzle facing a different direction, so that printing is effected on the recording paper simultaneously at two portions along a transportation direction in which the recording paper is transported through a single transportation path sequentially one by one.

According to the present invention, the ink carriage includes two ink heads each provided with an ink nozzle facing a different direction, so that printing is

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Consequently, there can be provided an ink jet printer which can improve printing efficiency by increasing a printing rate and printing resolution, and realizing printing of an overstrike character, simultaneous printing of mixed information, double-side printing, etc.

Still another ink jet printer of the present invention is the above ink jet printer, further characterized in that nozzle distance adjusting means for adjusting a distance between the two ink nozzles facing their respective directions is provided in the transportation path, so that printing is effect at two preset recording portions on the printing paper by the two ink heads provided with ink nozzles facing their respective directions.

In other words, unless a distance between the two ink nozzles in the transportation path along the transportation direction of the recording paper is adjusted, print can not be made exactly at the two preset recording positions by the ink head provided with the two ink nozzles facing their respective directions along the transportation direction of the recording paper.

Hence, by adjusting the distance between the two ink nozzles facing their respective directions in the transportation path by the nozzle distance adjusting means, printing can be effected exactly at two intended portions on the recording paper along the transportation direction thereof.

In addition, because the nozzle distance adjusting means adjusts the distance between the two ink nozzles facing their respective directions in the transportation

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path of the recording paper, print can be made exactly at two preset recording portions on the recording paper of any size.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by increasing a printing rate and printing resolution, and realizing printing of an overstrike character, simultaneous printing of mixed information, double-side printing, etc.

Moreover, according to the above arrangement, the recording paper of any size can be used.

Still another ink jet printer of the present invention is the above ink jet printer further characterized in that extendable guiding means for guiding the recording paper being transported whether the transportation path is extended or shortened is provided on the transportation path between the two ink nozzles.

That is, when the distance between the two nozzles facing their respective directions is adjusted by the nozzle distance adjusting means, the recording paper can not be transported adequately through in the extended/shorten transportation path unless it is guided.

For this reason, extendable guiding means for guiding the recording paper which is transported through extended/shortened transportation path between the two

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with a plurality of ink holes aligned in a line slanted downward with respect to a running direction along the supporting axis and the transportation direction of the recording paper for each color; and

the plurality of ink holes in one of the ink nozzles for each color are shifted by half the pitch from the plurality of ink holes in the other ink nozzle in intervals of the running direction along the supporting axis and/or the transportation direction of the recording paper.

According to the above arrangement, each of the two ink nozzles facing their respective directions along the transportation direction of the recording paper includes a plurality of ink holes aligned in a line slanted with respect to the running direction along the supporting axis and transportation direction of the recording paper for each color. In addition, the ink holes aligned in each ink nozzles for each color is shifted by half the pitch between the ink nozzles facing two different directions as to the interval in the running direction along the supporting axis and/or the intervals in the transportation direction of the recording paper.

Thus, the first printing is effected by the ink nozzle facing one direction, and the second print is effected by the ink nozzle facing the other direction so

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as to be superimposed on the print made by the first printing by shifting intervals in the running direction along the supporting axis and/or intervals along the transportation direction of the recording paper half the pitch. Hence, the resolution and printing density in the running direction along the supporting axis and/or transportation direction of the recording paper can be increased twice.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by improving printing resolution, etc.

Still another ink jet printer of the present invention is the above ink jet printer, further characterized in that first print data, such as a watermark, is printed out by one of the two ink nozzles and second print data, which is different from the first print data, for example, text information, is printed out by the other ink nozzle.

According to the above invention, the first print data, such as a watermark, is printed out by one of the two ink nozzles facing their respective directions along the transportation path of the recording paper, and the second print data different from the first print data, such as text information, is printed out by the other ink nozzle.

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printing is effected on the back surface of the recording paper.

According to the double-side printing mechanism, the printing is effected on the recording paper transported through the single transportation path by the two ink nozzles facing their respective directions. Thus, the double-side printing mechanism only has to turn over the recording paper between the ink nozzles facing two different directions, thereby making it possible to simplify the arrangement of the paper turnover means.

In addition, compared with a case of effecting the double-side printing by the conventional ink nozzle facing one direction, the printing is effected on the front surface of the recording paper by one of the two ink nozzles facing their respective directions, and on the back surface of the preceding recording paper by the other ink nozzle simultaneously. Thus, the double-side printing time can be reduced to the half compared with the conventional case when the double-side printing is effected on more than one recording paper.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by improving printing resolution, etc.

Still another ink jet printer of the present invention is the above ink jet printer, further

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characterized in that drying means for drying print made on the recording paper is provided in the transportation path.

In other words, when the printing is effected on the same recording paper by the two ink nozzles facing their respective directions in succession with a short time interval, if print made by one of the two ink nozzles facing their respective directions is not dried well before the printing by the other ink nozzle starts, smear of ink may occur or ink adhered to the transportation roller may dirty the recording paper.

For this reason, in the present invention, the drying means for drying print made by the ink nozzle on the recording paper is provided in the transportation path of the recording paper. Thus, the print made by one ink nozzle first is dried by the drying means.

Thus, when the printing is effected by the other ink nozzles later, smear of ink does not occur or the ink adhered to the transportation roller or the like does not dirty the recording paper, because the print made first is dried well by the drying means.

Consequently, there can be provided an ink jet printer which can improve printing efficiency by increasing a printing rate and printing resolution, and realizing printing of an overstrike character,

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simultaneous printing of mixed information, double-side printing, etc.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

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